MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2019/2020

DCE5038 – ELECTRICAL MEASUREMENT AND INSTRUMENTATION TECHNIQUES

(Diploma in Electronic Engineering)

22 OCTOBER 2019
2.30 p.m. – 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 4 pages excluding the cover page and appendix.
2. Answer **ALL** questions.
3. Please write all your answers in the answer booklet provided.

QUESTION 1 [25 MARKS]

a) Explain the difference between control system and display.

[4 marks]

b) Draw two diagrams that can explain the situation of:

i) high precision and low accuracy.

[2 marks]

ii) low precision and low accuracy.

[2 marks]

c) In an electric circuit, voltage can be measured by using formula of $V = IR$. Given that $R = 7\text{k} \pm 300\,\Omega$ and $I = 0.3 \pm 0.02$ A.

i) Calculate V.

[8 marks]

ii) If one more resistance, $R_1 = 1\text{k} \pm 5\%\ \Omega$ is connected in series with the existing R in the circuit. Calculate R_{eq}.

[5 marks]

d) List two aspects need to be considered when choosing instruments.

[2 marks]

Continued...

QUESTION 2 [25 MARKS]

a) Why is it important to have damping force in indicating instrument? State two examples of damping force used in instruments.

[4 marks]

b) Explain the advantages of moving iron instruments.

[8 marks]

c) Explain the operation of repulsion type moving iron instrument.

[8 marks]

d) Table 1 lists all the parameters involved for a measurement made with a wattmeter using the connection shown in Figure 1. Prove that power indicated by the wattmeter is 2527.1739 W:

Table 1

Parameter	Value
Voltage across load	250 V
Current across load	10 A
Current coil resistance	0.1 Ω
Pressure coil resistance	2.3 kΩ

[5 marks]

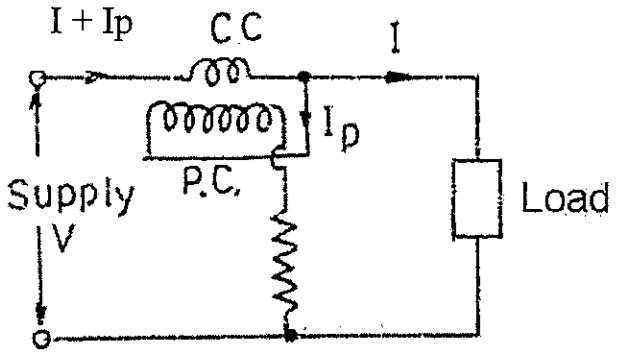

Figure 1

Continued...

QUESTION 3 [25 MARKS]

a) Given ratio arms (R_1 and R_2) with the value of 4 kΩ, a resistor R_3 = 10 kΩ, a galvanometer with internal resistance, R_G of 300 Ω, an unknown resistor R_x and an 8 V battery.

i) Draw the circuit diagram of the Wheatstone bridge with all the components given with correctly labelled them.

[7 marks]

ii) Find R_x for the bridge to become balanced.

[3 marks]

iii) Calculate the current through the galvanometer for R_x = 1.6 kΩ.

[9 marks]

b) A Maxwell bridge with a 30 kHz supply frequency has a 0.55 μF standard capacitor and a 100 Ω standard resistor for R_1. Resistors R_3 and R_4 can each be adjusted from 200 Ω to 2 kΩ. Based on the bridge shown in Figure 4, calculate the maximum value of the series inductance, $L_{s(max)}$ and maximum Q factor.

[6 marks]

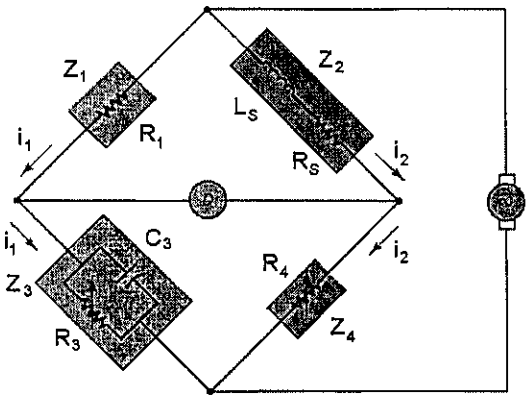

Figure 4

QUESTION 4 [25 MARKS]

a) An iron ring with a 12 mm^2 cross-sectional area and a mean length of 0.8 m is wound with a magnetizing winding of 158 turns. A secondary coil with 340 turns of wire is connected to a ballistic galvanometer having a constant of 1 μC per scale division. The total resistance of the secondary circuit is 2.1 kΩ. On reversing a current of 4 A in the magnetizing winding, the galvanometer shows a deflection of 100 scale divisions. Calculate:

i) the flux density in the specimen.

[2 marks]

ii) value of the permeability at this flux density.

[4 marks]

b) Explain the two main parts in a transducer.

[4 marks]

c) Define direct transducers and inverse transducers and explain on how piezo-electric crystal can act as both.

[6 marks]

d) A platinum resistance thermometer has a resistance of 120 Ω and 30 Ω at 100°C and 0°C respectively. If the resistance becomes 300 Ω when it is in contact with a type of gas, determine the temperature of that gas.

[5 marks]

e) A resistance strain gauge with a gauge factor of 1.6 is subjected to a strain of 1,800 microstrain. The original resistance of the gauge is 125Ω. Determine:

i) the Poisson's ratio of the gauge.

[2 marks]

ii) Change in the resistance, ΔR of the gauge.

[2 marks]

End of Page.

Appendix

$$X = AB$$

$$\frac{\partial X}{\partial A} = B,\ \frac{\partial X}{\partial B} = A$$

$$E_L = \frac{Z_L}{Z_L + Z_0} E_0$$

$$I_0 = \frac{E_0}{Z_O}$$

$$I_L = \frac{E_0}{Z_L + Z_0}$$

$$T_D = B\ell IND$$

$$Power\ loss\ in\ current\ coil = I^2 R_c$$

$$Power\ loss\ in\ pressure\ coil = \frac{V^2}{R_P}$$

$$QR = PS$$

$$V_{TH} = E\left[\frac{R_3}{R_1 + R_3} - \frac{R_4}{R_2 + R_4}\right]$$

$$R_{TH} = \left[\frac{R_1 R_3}{R_1 + R_3} + \frac{R_2 R_4}{R_2 + R_4}\right]$$

$$I_G = \frac{V_{TH}}{R_{TH} + R_G}$$

$$\frac{P}{Q} = \frac{R + \ell_1 R}{S + (L - \ell_1)R}$$

$$Q = 2\pi f C_3 R_3$$

$$Q = \frac{1}{2\pi f C_3 R_3}$$

$$R_S = \frac{R_1 R4}{R_3}$$

$$L_S = C_3 R_1 R_4$$

$$R_P = \frac{R_1 R4}{R_3}$$

$$L_P = C_3 R_1 R_4$$

$$C_1 = C_2 \frac{R_4}{R_3}$$

$$R_1 = \frac{R_3 C_4}{C_2}$$

$$H = \frac{N_P \ell}{\ell}$$

$$B = \frac{K\theta R_S}{2N_S A}$$

$$\mu = \frac{B}{H}$$

$$e_0 = \frac{X_i}{X_t} e_i$$

$$\nu = -\frac{\partial D / D}{\partial L / L}$$

$$G_f = \frac{\Delta R / R}{\Delta L / L} = 1 + 2\nu + \frac{\Delta\rho / \rho}{\varepsilon}$$

$$\varepsilon = \frac{\Delta L}{L}$$

$$G_f = 1 + 2\nu$$

$$Q = d \times F$$

$$E = \frac{Q}{C}$$

$$E = \left(\frac{d}{\varepsilon}\right) St = gSt$$

$$g = \frac{d}{\varepsilon}$$

$$C = \frac{\varepsilon A}{d}$$

$$R = R_0\left[1 + \alpha_0(\dot{\theta} - \theta_0)\right]$$

$$R = R_0 \exp\left[\beta\left(\frac{1}{T} - \frac{1}{T_0}\right)\right]$$

$$V_0 = C_1(T_1 - T_2) + C_2\left(T_1^2 - T_2^2\right)$$

End of Page.